



Medical Imaging Processing

fourth Stage

2025-2026

WAVELET DECOMPOSITION

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LEC9

Lecture 9: Wavelet Decomposition

- Introduction to Wavelets
- Multi-resolution Analysis
- Importance in Signal and Image Processing

Wavelet Decomposition Concept

- Signal/Image breakdown into frequency bands
- Low-pass and High-pass filters
- Approximation and Detail coefficients

Decomposition Structures

- One-Dimensional Decomposition
- Two-Dimensional Decomposition

1D Decomposition

- Approximation (A)
- Detail (D)
- Recursive decomposition on A

2D Decomposition

- LL: Approximation
- LH: Horizontal Details
- HL: Vertical Details
- HH: Diagonal Details

Editing Wavelet Coefficients

- Noise Reduction
- Compression
- Thresholding techniques

Editing Without Wavelet Toolbox

- Manual filter definition
- Convolution
- Downsampling and Upsampling

Displaying Wavelet Coefficients

- 1D Signal Visualization
- 2D Image Sub-band Display

Applications of Decomposition

- Medical Signals
- Seismic Analysis
- Data Compression



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INVERSE FAST WAVELET TRANSFORM

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Lecture 10: Inverse Fast Wavelet Transform

- Reconstruction process
- Importance of IFWT

Inverse Fast Wavelet Transform

- Upsampling
- Reconstruction Filters
- Signal Summation

Perfect Reconstruction

- No information loss
- Filter design importance

Mathematical Representation

- Linear combination of coefficients
- Inverse filtering

Wavelets in Image Processing

- Compression
- Denoising
- Edge Detection

Image Compression

- JPEG2000 Standard
- Significant coefficients only

Image Denoising

- Thresholding detail coefficients
- Edge preservation

Edge Detection

- High-frequency coefficients
- Boundary enhancement

Practical Examples

- MRI Images
- Satellite Images
- X-ray Images

Advantages of Wavelets

- Multi-resolution
- Efficient Compression
- Detail Preservation

Limitations and Conclusion

- Mathematical complexity
- Wavelet selection
- Accurate reconstruction